

APPARATUS AND METHOD FOR CONTAINING AND REGULATING THE PRESSURE
IN A PRESSURE VESSEL

BACKGROUND OF THE INVENTION

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[0001] Some homes and businesses are not served by municipal water services. These homes and businesses generally utilize a private well to solve their water needs. With a private well, water is drawn from a water bearing aquifer in the ground and pumped to a storage tank containing a fixed amount of air. As water enters the tank, the air volume occupied by the air is reduced and the pressure within the tank rises. The tank is therefore a pressure accumulator that
10 delivers water to a faucet or other end use location without requiring the pump to cycle every time water is drawn from the tank.

SUMMARY OF THE INVENTION

[0002] Some aspects of the present invention are directed toward improving the process of manufacturing and preparing a pressure tank assembly. During conventional manufacturing processes, the pressure tank is generally pressure tested. As part of the pressure test, an air pressure sensing assembly or regulator valve assembly is attached to the tank to seal an opening in the tank and to introduce air into the tank. After the pressure test, the regulator assembly is removed from the tank so the tank can be easily painted. However, this step also causes the tank to be depressurized. Once the tank is painted, a pressure regulator valve assembly is attached to the tank again and the tank is pressurized again. The tank is generally then sold with the pressure regulator valve attached and with the tank pressurized.

[0003] The inventors have developed a method for manufacturing a tank that can reduce one or more of these redundant steps. Furthermore, they have developed a tank and a pressure sensing assembly that can be used with said method. For example, some embodiments relate to a method of manufacturing a water storage tank for a well. The method can include one or more steps such as forming a pressure vessel having an opening, an interior volume, and an elastic member located inside the pressure vessel to separate the interior volume into a water storing volume and an air storing volume; installing a seal over the opening, wherein the seal is capable of sealing the entire opening and is adapted to be punctured by a pressure switch mounting assembly; pressurizing the tank with air; preventing air from escaping the pressurized tank through the opening with the seal; and packaging the pressurized tank for shipping while the tank is pressurized.

[0004] Other embodiments relate to a water storage tank adapted to selectively release water and refill with water delivered from a well via a water pump, wherein the tank comprises a pressure vessel having an opening and an interior volume, an elastic member located inside the pressure vessel and separating the interior volume into a water storing volume and an air storing volume, and a seal located over the opening. The seal allows the tank to be pressurized and remain pressurized without additional structure closing the opening.

[0005] Yet other embodiments relate to an apparatus connectable to a water storage tank (having a volume of stored air) that can selectively release water and refill with water delivered from a well via a water pump. The apparatus comprises a conduit connectable with the tank and defining an air passage in communication with the stored air in the tank and an air pressure switch coupled to the conduit. The air pressure switch communicates with the air passage and is operable to activate the pump if the air pressure within the tank drops below a first limit. A projection is contiguous with and extends from the conduit in a direction away from the pressure switch. The projection has an end capable of piercing a seal on the tank.

[0006] Once a conventional tank (that uses air pressure within the tank to trigger the pump) is installed, problems can arise when air leaks from the tank into the atmosphere. This can occur in some situations because the installer may have used the air pressure sensing assembly as a handle to move the tank into its operating position, which could damage the valve and cause a leak. Leaks, however, can occur for other reasons as well. Regardless of how the leak develops, as the air leaks out, a reduction in pressure will cause the pressure switch to activate the pump. Although the pump will deliver water to the tank, the air pressure will generally not rise to the preset limit needed to turn the pump off due to the leak. Furthermore, since the water is prevented from reaching the pressure switch, the water pressure cannot turn the pump off. Consequently, the pump will continuously add water to the tank until there is a pump failure or until the pressure system fails by developing a leak on the waterside. For example, seams of some conventional tanks have ruptured due to the water pressure within the tank.

[0007] Thus, some embodiments of the present invention are adapted to avoid this problem. For example, some embodiments relate to a tank and pressure sensing assembly that does not need to be attached to the tank until the tank is in its final operating position. If the pressuring sensing assembly is not attached to the tank, it cannot be used as a handle.

[0008] Other embodiments also relate to a water storage apparatus for selectively storing and releasing water delivered from a well via a water pump. Specifically the apparatus has a pressure vessel having an opening and an interior volume and an elastic member inside the pressure vessel. The elastic member separates the interior volume into a water storing volume and an air storing volume. The water storing volume communicates with the water pump and

fills with water supplied by the pump. The air storing volume contains a fixed amount of air. The air storing volume decreases in response to water being pumped into the water storing volume, and the pressure within the tank consequently rises. On the other hand, the pressure in the tank decreases as water is drawn from the tank and the air storing volume expands. A conduit
5 is located in the pressure vessel opening and defines an air passage in communication with the air storing volume. An air pressure switch is located in communication with the air passage and adapted to activate the pump in response to the air pressure in the air storing volume dropping below a first limit and deactivating the pump in response to air pressure rising above a second limit. The second limit is greater than the first limit. Also, a piercing member is contiguous with
10 the conduit and extends into the air storing volume to pierce the elastic member in the event that the elastic member contacts the piercing member due to the air storing volume shrinking below a normal operating range of volumes.

[0009] Other embodiments are directed to a water storage apparatus for selectively storing and releasing water delivered from a well via a water pump. The water storing apparatus can
15 include a pressure vessel having an opening and an interior volume and an elastic member inside the pressure vessel. The elastic member separates the interior volume into a water storing volume and an air storing volume. A conduit is positioned in the pressure vessel opening to define an air passage in communication with the air storing volume. An air pressure switch communicates with the air passage and is adapted to activate the pump in response to the air
20 pressure in the air storing volume dropping below a first limit. A piercing member is connected with the conduit and extends through the opening and into the air storing volume to pierce the elastic member in the event that the elastic member contacts the piercing member due to the air pressure dropping below a second limit less than the first limit.

[0010] Further aspects of the present invention, together with the organization and operation
25 thereof, will become apparent from the following detailed description of the invention when taken in conjunction with the accompanying claims and drawings, wherein like elements have like numerals throughout the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is further described with reference to the accompanying drawings, which show certain embodiments of the present invention. However, it should be noted that the invention as disclosed in the accompanying drawings is illustrated by way of example only. The various elements and combinations of elements described below and illustrated in the drawings can be arranged and organized differently to result in embodiments which are still within the spirit and scope of the present invention.

[0012] In the drawings, wherein like reference numeral indicate like parts:

10 [0013] FIG. 1 is a schematic elevation view of a water pressure system;

[0014] FIG. 2 is an exploded partial cross-section of a diaphragm pressure tank and pressure regulator embodying aspects of the invention;

[0015] FIG. 3 is an exploded partial cross-section of a pressure tank and pressure regulator embodying aspects of the invention;

15 [0016] FIG. 4 is a partial cross-sectional side view of a pressure regulator mounted on a pressure tank;

[0017] FIG. 5 is a partial cross-sectional side view of a pressure regulator mounted on a pressure tank;

20 [0018] FIG. 6 is a partial cross-sectional side view of a pressure regulator mounted on a pressure tank;

[0019] FIG. 7 is a partial cross-sectional side view of a pressure regulator mounted on a pressure tank;

[0020] FIG. 8 is a cross-section of the pressure tank illustrated in FIG. 2 having a leak on the air storage side of the tank; and

[0021] FIG. 9 is a cross-section of the pressure tank illustrated in FIG. 3 having a leak on the air storage side of the tank.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0022] As illustrated in FIG. 1, a water pressure system for a well generally has a drop pipe extending into a water bearing aquifer, and a pump is used to deliver water from the aquifer to a pressure vessel or storage tank 12. Several types of pumps can be used, such as submersible pumps and non-submersible pumps. Water from the pressure tank 12 can be distributed from the tank for use.

[0023] The pressure tank 12 generally holds a reserve supply of water under pressure within the tank until it is needed. As water is drawn from the tank 12, the pressure within the tank 12 forces the water out of the tank 12 and consequently the pressure gradually decreases. A pressure switch 14 coupled to the tank 12 is used to maintain the pressure within the tank 12 between a preset minimum value and a preset maximum value. Upon reaching the preset minimum pressure, the pressure switch 14 automatically activates the pump. Water is then pumped into the tank 12 to replenish the tank 12 with water and to build up the pressure within the tank 12 to the preset maximum value. Once the pressure within the tank 12 has reached the preset maximum value, the pressure switch 14 stops the pump from operating.

[0024] An elastic member 15 typically separates the pressure tank 12 into a water storing portion 18 and an air storing portion 21 as illustrated in FIGS. 2 and 3. The elastic member 15 is generally a diaphragm or bladder as illustrated in FIG. 2. However, in other embodiments, the elastic member can be bag or balloon-like member as illustrated in FIG. 3. A diaphragm or bladder (FIG. 2) generally attaches to the sides of the tank along the inner periphery of the tank 12 to separate the two portions. The construction of the tank and elastic members are well understood in the art and therefore will not be discussed in detail.

[0025] Under normal operating conditions the pressure in the air storing portion 21 and the water storing portion 18 are about the same. Therefore, the pressure switch 14 can sense the pressure in either portion. The operation of an air pressure switch operates as follows. As the water level in the tank 12 drops, the volume 18 within the tank 12 occupied by the water drops. This allows the fixed amount of air to increase the amount of space or volume it occupies, and consequently causes the air pressure to drop. Once the air pressure drops below the preset

minimum limit, the pressure switch 14 activates the pump to deliver more water to the tank and increase the pressure within the tank 12.

5 [0026] The air storing portion 21 can be pressurized with air via an air valve 32 located on the side of the tank (FIG. 2) or via an air valve 32 located on an air pressure sensing assembly 33 (FIG. 3). Regardless of the location of the valve 32, the air storing portion 21 of the tank 12 has an opening or spud 30 that receives the air pressure sensing assembly 33.

[0027] Some embodiments of the invention have a seal 39 positioned over the opening 30 or in the opening 30. Depending upon how the seal 39 is used, it can help reduce the number of times the tank needs to be pressurized and depressurized while manufacturing the tank 12.

10 Conventionally, an air gauge would be threaded into the spud, and the tank would be pressure tested. Then the air gauge would be removed so the tank could be painted. Next the air gauge would again be threaded into the spud so the tank could be pressurized. The pressurized tank would then be shipped with the air gauge installed.

[0028] With the use of the seal 39 of the present invention, the opening of the tank 12 can be sealed while being manufactured. The tank can then be pressurized without the need to attach the air pressure sensing assembly 33 to the tank 12. Additionally, since the air pressure sensing assembly 33 is not attached to the tank prior to the painting process, it does not need to be detached. Consequently, the tank 12 can remain pressurized during the painting operation. Additionally, the pressurized tank 12 can be shipped without the air pressure sensing assembly

15 33 attached. The potential for damage to the air pressure sensing assembly 33 can be reduced by shipping it separately from the tank.

[0029] The seal 39 can be made from several different types of materials, such as elastic, resilient, inelastic, or frangible materials depending upon the purpose of the seal 39. For example, as will be discussed further below, the seal 39 may be able to selectively open and

25 close the air volume. In such a situation, elastic materials may be desirable.

[0030] The seal 39 can be attached to the inside of the tank 12, to the outside of the tank, or a combination of the two. The seal can also be located entirely on one side of the opening 30, in the opening 30, on both sides of the opening 30, or combination of the above. The seal 39 can be

coupled to the tank in one or more conventional fastening techniques, such as with adhesive or cohesive bonds, welds, rivets, friction fits, interference fits, other conventional fasteners, and the like.

5 [0031] The seal 39 can be punctured or pierced by a piercing member 42 located at the end of the air pressure sensing assembly 33 while the air pressure sensing assembly 33 is being attached to the tank 12. Preferably, the seal is not fully punctured or pierced until the air pressure sensing assembly 33 is sufficiently engaged with the opening 30 of the tank 12 to prevent leakage of air. For example, if the air pressure sensing assembly 33 were threaded into a spud surrounding the opening 30, the piercing member 42 would not fully pierce the seal 39 until
10 the threads of the air pressure sensing assembly 33 and the spud were sufficiently engaged to prevent leakage. However, this does not mean that the air pressure sensing assembly 33 is resting in its fully engaged position with the spud. Rather, it only needs to be engaged sufficiently enough to prevent substantial leakage. Preferably, it prevents all leakage.

15 [0032] The piercing member 42 can have a variety of embodiments. For example, it can be a solid needle, a hollow needle, a blade, a blunt end projection, a cylindrical projection, a pointed object, a helical projection, and the like. In some preferred embodiments, the piercing member 42 is similar to a hypodermic needle. As illustrated in FIGS. 4-7, the piercing member 42 of some embodiments has a hollow center that is in communication with a conduit 45 of the air pressure sensing assembly 33. Specifically, the hollow center is aligned with the conduit 45.
20 This allows air to travel through the projection and into the air pressure sensing assembly 33. In some embodiments, the piercing member 42 can be formed integrally with the air pressure sensing assembly 33 as shown in FIGS 4 and 5. However, in other embodiments, the piercing member 42 can be formed separately from and positioned contiguous with and extend from the air pressure sensing assembly 33. In such embodiments, the piercing member could have a
25 shoulder 43 that rests on a ledge 44 within the opening 30 as shown in FIGS. 6 and 7.

[0033] The air pressure sensing assembly 33 can be constructed several different ways and with several different components – as is understood in the art. For example, FIGS. 4 and 6 illustrate two different configurations of an air pressure sensing assembly 33. Each assembly 33 has a conduit 45 coupled to the opening of the tank 12 and in communication with the air storing

portion 21 of the tank. A pressure switch 14 and an air gauge 51 are coupled to the conduit 45 and in communication with the air storing volume via the conduit 45. As illustrated, the arrangement of these elements in FIG. 4 is slightly different than the arrangements in FIG. 6. A person having ordinary skill in the art will understand that other arrangements are possible and various components can be added or removed. Such variations fall within the spirit and scope of the present invention. For example, the air gauge 51 may not be necessary in some embodiments and could therefore be omitted.

[0034] The pressure switch 14 and the air gauge 51 sense the pressure within the conduit 45. The air gauge 51 provides a visual indication of pressure within the tank 12. The pressure switch 14 also senses the pressure within the tank 12 and compares the measured pressure with preset limits to determine whether to active the pump. If the pressure is below the desired pressure range, the pump will deliver water to the tank 12 to increase the pressure within the tank 12. When the pressure switch 14 activates the pump, it can also deactivate the pump once the pressure rises above another preset limit at the upper end of the desired operating range. In some typical systems, for example, the pump will be activated when the pressure within the tank drops below thirty pounds per square inch and will be deactivated when the pressure exceeds fifty pounds per square inch. Other preset limits are also used and fall within the spirit and scope of the present invention.

[0035] FIGS. 5 and 7 illustrate two other configurations of an air pressure sensing assembly 33. Like the previous assemblies, these assemblies 33 each have a conduit 45 coupled to the opening 30 of the tank 12 and in communication with the air storing portion 21 of the tank. In addition to the pressure switch 14 and air gauge 51 seen in the previous assemblies, this assembly also has an air valve 32 attached to the conduit 45 and in communication with the air storing volume via the conduit 45. As illustrated, the arrangement of these elements in FIG. 5 is slightly different than the arrangement in FIG. 7. A person having ordinary skill in the art understands that other arrangements are possible and various components can be added or removed. Such variations fall within the spirit and scope of the present invention.

[0036] The assemblies 33 shown in FIGS. 4 and 6 can allow the tank to be tested in a different manner than the assemblies shown in FIGS. 5 and 7. However, they do not necessarily

need to be tested differently. For example, the air pressure sensing assemblies 33 illustrated in FIGS. 4 and 6 do not need to be attached to the tank 12 for the tank 12 to be pressure tested. As illustrated, an air valve 32 is attached to the tank 12 separate from the air pressure sensing assembly 33. As such, air can be introduced through this valve 32 to pressurize the tank without the need to attach the air pressure sensing assembly 33.

[0037] In some embodiments, however, the air pressure sensing assembly 33 can be coupled to the tank for some operations and later removed without losing a substantial amount of pressure. These embodiments can utilize a resilient, self-closing seal 39 similar to the valves used on inflatable athletic balls. Thus, the piercing member 42 can penetrate the seal 39 and be removed from the seal 39 with the seal preventing substantial air loss. This arrangement would typically be used with the air pressure sensing assemblies 33 illustrated in FIG. 5, wherein the assembly 33 has an air valve 32 and the piercing member 42 is integral with the assembly 33. However, they can also be used with other assemblies 33, such as the embodiment illustrated in FIG. 4. Specifically, the assembly 33 illustrated in FIG. 5 can be attached to the tank 12 and used to introduce air into the tank 12 via air valve 32 during the pressure test. The assembly 33 can then be removed for the painting operation. Upon removal of the air pressure sensing assembly 33, the resilient, self-closing seal 39 will seal the opening 30 and prevent substantial pressure losses from occurring. Then, during later operations, the air pressure sensing assembly 33 can be coupled to the tank 12. Although this method and assembly requires the additional steps of removing and re-attaching the air pressure sensing assembly 33 when compared to the previously discussed embodiments, it still eliminates the need to depressurize and repressurize the tank 12 when compared to conventional tanks.

[0038] Under certain conditions, the piercing member 42 can also pierce the elastic member 15 that separates the water containing portion 18 from the air containing portion 21. For example, if the air containing portion 21 portion were to develop an atmospheric leak as shown FIGS. 8 and 9, the pressure sensed by the pressure switch would drop and eventually trigger the pump to activate. Since the elastic member 15 separates the water containing portion 18 from the air containing portion 21, the addition of water to the tank 12 will not cause an increase in pressure in the air containing portion 21. Theoretically, the pump would continue to operate

until the tank 12 or a waterline developed a leak or burst. However, if water were able to reach the pressure switch, the water pressure could cause the pump to turn off.

[0039] One way to allow water to reach the pressure switch is to pierce the elastic member 15 with the piercing member 42. As water continues to fill the tank, the elastic member 15 will be pushed closer to top of the tank 12. Eventually, the elastic member 15 will contact and be pierced by the piercing member 42. This will allow water to penetrate the air storing portion and contact the pressure switch to deactivate the pump. By aligning the piercing member 42 with the conduit 45, water can reach the pressure switch 14 relatively quickly. Specifically, since the conduit 45 is in communication with the hollow portion of the piercing member 42, water can enter the conduit 45 immediately after the piercing member 42 pierces the elastic member 15. The owner of the tank 12 may be alerted to the air leak by the pump cycling every time water is drawn from the tank.

[0040] The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention. For example, various alternatives to the certain features and elements of the present invention are described with reference to specific embodiments of the present invention. With the exception of features, elements, and manners of operation that are mutually exclusive of or are inconsistent with each embodiment described above, it should be noted that the alternative features, elements, and manners of operation described with reference to one particular embodiment are applicable to the other embodiments.